UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Pertama
Sidang Akademik 2006/2007

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# EKC 106 – Kimia Fizik

Masa : 3 jam

Sila pastikan bahawa kertas peperiksaan ini mengandungi EMPAT BELAS muka surat yang bercetak dan EMPAT muka surat Lampiran sebelum anda memulakan peperiksaan ini.

**Arahan:** Jawab **LAPAN BELAS (18)** soalan. Jawab mana-mana **DUA (2)** soalan dari Bahagian A. Jawab mana-mana **EMPAT (4)** soalan dari Bahagian B. Jawab mana-mana **DUA BELAS (12)** soalan dari Bahagian C. **Sila kembalikan kertas soalan ini bersama-sama dengan kertas jawapan**.

Pelajar boleh menjawab semua soalan dalam Bahasa Malaysia. Jika pelajar ingin menjawab dalam Bahasa Inggeris, pelajar hendaklah menjawab sekurang-kurangnya SATU soalan dalam Bahasa Malaysia.

...2/-

Section A : Answer any TWO questions.
*Bahagian A : Jawab mana-mana DUA soalan.*

1. [a] Find all the state functions in the gas equation of state using Euler's technique.

*[6 marks]*

[b] An ideal gas is heated from 300 to 1000 K and the pressure is allowed to raise from 1 to 2 bar. Calculate the change in molar entropy.

Given : $C_{v,m} = \frac{3}{2}R$

*[5 marks]*

[c] For a reversible isothermal process, prove that heat depends on the path of the process. Use appropriate figure to illustrate your point.

*[10 marks]*

[d] In a reversible, isothermal process, 3 moles of $N_2$ gas at 2 bars expand its volume by double. Calculate $\Delta S_{N_2}$

*[4 marks]*

*1. [a] Dapatkan kesemua fungsi keadaan daripada persamaan keadaan gas dengan menggunakan teknik Euler.*

*[6 markah]*

*[b] Suatu gas unggul dipanaskan dari 300 hingga 1000 K dan tekanan ditingkatkan dari 1 ke 2 bar. Kirakan perubahan entropi molarnya.*

*Diberikan :* $C_{v,m} = \frac{3}{2}R$

*[5 markah]*

*[c] Bagi proses isoterma berbalik, buktikan bahawa haba bergantung kepada laluan proses tersebut. Gunakan gambarajah yang bersesuaian untuk menjelaskannya.*

*[10 markah]*

*[d] Di dalam proses isoterma berbalik, 3 mol gas $N_2$ pada 2 bar mengembang isipadunya sebanyak 2 kali ganda. Kirakan* $\Delta S_{N_2}$

*[4 markah]*

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2. [a] For most liquids and solids, their molar volume can be expressed as

$$V_m = C_1 + C_2 T + C_3 T^2 - C_4 P - C_5 P T$$

Where $C_1$ to $C_5$ are constants.

Obtain the expression for the cubic expansion coefficient, $\alpha$ and isothermal compressibility, $\kappa$

*[6 marks]*

[b] For mixing 3 moles of $N_2$ and 6 moles of He at 70°C and 4 bars, calculate

[i] $\Delta U$ (kJ)

*[3 marks]*

[ii] $\Delta H$ (kJ)

*[3 marks]*

[iii] $\Delta S$ ($JK^{-1}$)

*[6 marks]*

[iv] $\Delta A$ (kJ)

*[4 marks]*

[v] $\Delta G$ (kJ)

*[3 marks]*

2. *[a] Bagi kebanyakan cecair dan pepejal isipadu molarnya diberikan seperti berikut:*

$$V_m = C_1 + C_2 T + C_3 T^2 - C_4 P - C_5 P T$$

*di mana $C_1$ hingga $C_5$ adalah pemalar..*

*Dapatkan persamaan bagi pekali pengembangan kubik, $\alpha$ dan pemampatan isoterma, $\kappa$*

*[6 markah]*

*[b] Bagi pencampuran 3 mol $N_2$ dan 6 mol He pada 70°C dan 4 bars, kirakan*

*[i] $\Delta U$ (kJ)*

*[3 markah]*

*[ii] $\Delta H$ (kJ)*

*[3 markah]*

*[iii] $\Delta S$ ($JK^{-1}$)*

*[6 markah]*

*[iv] $\Delta A$ (kJ)*

*[4 markah]*

*[v] $\Delta G$ (kJ)*

*[3 marks]*

3. [a] Write the reaction for the formation of urea, $CO(NH_2)_2$ from $CO_2$ and $NH_3$.

*[4 marks]*

[b] Calculate the $\Delta_f G^\circ_{298}$ (kJ/mol) for the urea formation,

Given: For urea formation,

$\Delta_f H^\circ_{298}$ = -333.51 kJ/mol

$S^\circ_{298}$ = 104.60 J/mol.K

*[7 marks]*

[c] Calculate the standard enthalpy of formation for the production of methanol from synthesis gas via indirect route by steam reforming of methane.

Given : $CO + 2H_2 \rightleftharpoons CH_3OH$ $\Delta_f H^\circ_{298}$ = -90 kJ/mol

*[14 marks]*

*3. [a] Tuliskan tindakbalas pembentukan bagi urea $CO(NH_2)_2$ daripada $CO_2$ dan $NH_3$.*

*[4 markah]*

*[b] Kirakan $\Delta_f G^\circ_{298}$ (kJ/mol) bagi pembentukan urea,*

*Diberikan: Bagi pembentukan urea,*

*$\Delta_f H^\circ_{298}$ = -333.51 kJ/mol*

*$S^\circ_{298}$ = 104.60 J/mol.K*

*[7 markah]*

*[c] Kirakan entalpi piawai pembentukan dalam penghasilan metanol daripada gas sintesis melalui laluan tak langsung pembentukan semula metana daripada stim.*

*Diberikan : $CO + 2H_2 \rightleftharpoons CH_3OH$ $\Delta_f H^\circ_{298}$ = -90 kJ/mol*

*[14 markah]*

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Section B : Answer any FOUR questions.
*Bahagian B : Jawab mana-mana EMPAT soalan.*

4. The homogeneous gas phase reaction **A + 2B → 2C + D** was studied at 25°C and the following data were obtained.

| *Expt.* | $A_o$, *M* | $B_o$, *M* | *Rate, M/s* |
|---|---|---|---|
| 1 | 0.555 | 0.331 | $1.32 \times 10^{-5}$ |
| 2 | 0.451 | 0.732 | $2.38 \times 10^{-5}$ |
| 3 | 0.555 | 0.221 | $8.83 \times 10^{-6}$ |

[a] Determine the specific rate law for the reaction.

[b] Calculate the value of reaction rate constant, *k* including units, at 25°C.

[c] Calculate the rate of the reaction when the initial concentrations of A and B are 0.100 ***M*** and 0.200 ***M***, respectively.

*[6.5 marks]*

4. *Tindakbalas fasa gas homogen **A + 2B → 2C + D** dikaji pada 25°C dan data berikut diperolehi.*

| *Eksperimen* | $A_o$, *M* | $B_o$, *M* | *Kadar, M/s* |
|---|---|---|---|
| *1* | *0.555* | *0.331* | $1.32 \times 10^{-5}$ |
| *2* | *0.451* | *0.732* | $2.38 \times 10^{-5}$ |
| *3* | *0.555* | *0.221* | $8.83 \times 10^{-6}$ |

*[a] Tentukan hukum kadar tentu bagi tindakbalas tersebut.*

*[b] Kirakan nilai pemalar kadar tindakbalas k, termasuk unitnya pada 25°C.*

*[c] Kirakan kadar tindakbalas apabila kepekatan awal A dan B adalah masing-masing 0.100 **M** dan 0.200 **M**.*

*[6.5 markah]*

5. Suppose that the average rate of formation of product C in the reaction **3A + 2B → 4C + 2D** is $4.2 \times 10^4$ M/s at 25°C for a given time period. Calculate the average rate of disappearance of reactant B and the average rate of the reaction at 25°C for the same time period.

*[6.5 marks]*

5. *Andainya kadar purata pembentukan produk C di dalam tindakbalas **3A + 2B → 4C + 2D** adalah $4.2 \times 10^4$ M/s pada 25°C bagi tempoh yang diberikan. Kirakan kadar purata penggunaan bahan tindakbalas B dan kadar purata tindakbalas tersebut pada 25°C bagi tempoh masa yang sama.*

*[6.5 markah]*

6. The equilibrium constant for the reaction below is given as Kc = $2.0 \times 10^{-27}$ at 25°C

$$2Cu^{2+}(aq) + Hg_2^{2+}(aq) \leftrightarrows 2Cu^{+}(aq) + 2Hg^{2+}(aq)$$

[a] Calculate $E°_{cell}$ for the reaction at 25°C.

[b] Calculate ΔG for the reaction when the initial concentrations are as follows: $(Cu^{2+})$ = 0.0010 M, $(Hg_2^{2+})$ = 0.0020 M, $(Cu^{+})$ = 0.10 M, and $(Hg^{2+})$ = 0.20 M.

Which way the reaction will shift from the initial concentrations in order to reach equilibrium?

*[6.5 marks]*

6. *Pemalar keseimbangan bagi tindakbalas di bawah adalah Kc = $2.0 \times 10^{-27}$ pada 25°C*

$$2Cu^{2+}(ak) + Hg_2^{2+}(ak) \leftrightarrows 2Cu^{+}(ak) + 2Hg^{2+}(ak)$$

*[a] Kirakan $E°_{sel}$ bagi tindakbalas pada 25°C.*

*[b] Kirakan ΔG bagi tindakbalas apabila kepekatan awal adalah seperti berikut: $(Cu^{2+})$ = 0.0010 M, $(Hg_2^{2+})$ = 0.0020 M, $(Cu^{+})$ = 0.10 M, dan $(Hg^{2+})$ = 0.20 M.*

*Arah manakah tindakbalas beralih berdasarkan kepekatan awal supaya dapat mencapai keseimbangan?*

*[6.5 markah]*

7. A galvanic cell consists of a silver anode in 400 mL of 0.100 M aqueous $AgNO_3$ and a gold cathode in 650 mL of 0.400 M $Au(NO_3)_3$. The two electrodes are connected via a conducting wire with a voltmeter and the two solutions are connected via a salt bridge containing $NaNO_3$.

[a] What is the initial $E_{cell}$ ?

[b] What is $E_{cell}$ after 42.0 g of gold have formed on the cathode?

*ANODE:* $Ag_{(s)} \rightarrow Ag^{+}_{(aq)} + e$
*CATHODE:* $Au^{3+}_{(aq)} + 3e \rightarrow Au_{(s)}$

*[6.5 marks]*

7. *Sel galvani terdiri daripada anod perak di dalam 400 mL 0.100 M $AgNO_3$ akues dan katod emas di dalam 650 mL 0.400 M $Au(NO_3)_3$. Kedua-dua elektrod dihubungkan melalui wayar pengaliran dengan voltmeter dan kedua-dua larutan dihubungkan oleh titian garam mengandungi $NaNO_3$.*

*[a] Apakah $E_{sel}$ awal?*

*[b] Apakah $E_{sel}$ selepas 42.0 g emas terbentuk di atas katod?*

*ANOD:* $Ag_{(p)} \rightarrow Ag^{+}_{(ak)} + e$
*KATOD:* $Au^{3+}_{(ak)} + 3e \rightarrow Au_{(p)}$

*[6.5 markah]*

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8. The density of 2.41 molal aqueous solution of $Mg(NO_3)_2$ (MW = 148.3 g/mole) is 1.108 g/mL. Calculate the followings :

[a] The percent by mass of $Mg(NO_3)_2$ in the solution.

[b] The molarity of $Mg(NO_3)_2$ in the solution.

[c] The mole fraction of $Mg(NO_3)_2$ in the solution.

*[6.5 marks]*

8. *Ketumpatan larutan akues 2.41 molal $Mg(NO_3)_2$ (Berat Molekul = 148.3 g/mol) adalah 1.108 g/mL. Kirakan yang berikut :*

*[a] Peratus jisim $Mg(NO_3)_2$ di dalam larutan.*

*[b] Kemolaran $Mg(NO_3)_2$ di dalam larutan.*

*[c] Pecahan mol $Mg(NO_3)_2$ di dalam larutan.*

*[6.5 markah]*

9. A solid organic compound contains carbon, hydrogen and oxygen. A solution of 0.650 g of this compound in 27.80 g of biphenyl melts at 68.54°C. The normal melting point of biphenyl is 70.10°C and its freezing point constant, $K_f$, is 8.00°C/m. What is the molecular weight of the compound in two significant figures?

*[6.5 marks]*

9. *Sebatian organik pepejal mengandungi karbon, hidrogen dan oksigen. Larutan mengandungi 0.650 g sebatian ini di dalam 27.80 g bifenil lebur pada 68.54°C. Titik lebur biasa bifenil adalah 70.10°C dan pemalar titik beku, $K_f$, adalah 8.00°C/m. Apakah berat molekul sebatian ini di dalam dua angka beerti?*

*[6.5 markah]*

Section C : Answer any TWELVE questions.
*Bahagian C : Jawab mana-mana DUA BELAS soalan.*

**[Each question is worth of two points, for a total of 24 points. Answer each question by circling the letter corresponding to the correct choice.]**
***[Setiap soalan bernilai dua markah untuk memberi jumlahnya 24 markah. Jawab setiap soalan dengan membulatkan huruf yang sepadan dengan pilihan yang betul.]***

10. Suppose that the average rate of appearance of **D** in the reaction **3A + 2B → C + 4D** is 0.250 mole/(L) (s). What is the average rate of disappearance of **A** over the same time period?

[a] 0.750 mole/(L) (s)
[b] 0.188 mole/(L) (s)
[c] 0.333 mole/(L) (s)
[d] 0.500 mole/(L) (s)
[e] none the above

*10. Andaikan kadar purata pembentukan **D** dalam tindakbalas **3A + 2B → C + 4D** adalah 0.250 mol/(L) (s). Apakah kadar penggunaan **A** melalui tempoh yang sama?*

*[a] 0.750 mol/(L) (s)*
*[b] 0.188 mol/(L) (s)*
*[c] 0.333 mol/(L) (s)*
*[d] 0.500 mol/(L) (s)*
*[e] Tiada satu pun yang di atas*

11. Which of the following are possible units for the reaction **A + 2B → C + D** with the rate law, **rate = k[A][B]**?

[a] mole/(L) (s)
[b] $mole^2$/(L) (s)
[c] L/mole (s)
[d] $L^2/mole^2$ (s)
[e] none the above

*11. Yang manakah antara berikut adalah unit yang mungkin bagi tindakbalas **A + 2B → C + D** dengan hukum kadar, **kadar = k[A][B]**?*

*[a] mol/(L) (s)*
*[b] $mol^2$/(L) (s)*
*[c] L/mol (s)*
*[d] $L^2/mol^2$ (s)*
*[e] Tiada satu pun yang di atas*

12. Consider the decomposition reaction **A** → **B** + **C** that is first-order in **A**. Suppose that 35% of the original amount of A has decomposed after 112 minutes at 25°C. What is the value of the rate constant, k, at this temperature (k values given have time units of minutes)?

[a] $4.7 \times 10^{-3}$
[b] $9.4 \times 10^{-3}$
[c] $3.8 \times 10^{-3}$
[d] $5.5 \times 10^{-3}$
[e] none the above

*12. Pertimbangkan tindakbalas penguraian **A** → **B** + **C** yang merupakan tertib pertama bagi **A**. Andaikan 35% nilai asal A terurai selepas 112 minit pada 25°C. Apakah nilai pemalar kadar, k, pada suhu ini (nilai k diberi mempunyai unit masa dalam minit)?*

*[a]* $4.7 \times 10^{-3}$
*[b]* $9.4 \times 10^{-3}$
*[c]* $3.8 \times 10^{-3}$
*[d]* $5.5 \times 10^{-3}$
*[e] Tiada satu pun yang di atas*

13. What is the half-life of the reaction in question no.12 at the same temperature?

[a] 56 minutes
[b] 150 minutes
[c] 86 minutes
[d] 74 minutes
[e] 180 minutes

*13. Apakah separuh hayat tindakbalas di dalam soalan 12 pada suhu yang sama?*

*[a] 56 minit*
*[b] 150 minit*
*[c] 86 minit*
*[d] 74 minit*
*[e] 180 minit*

14. Which of the mechanism below is plausible for the reaction, **2A +B → 3C**, which follows the rate law, **Rate = k(A)$^2$** ?

[a] Mechanism I
[b] Mechanism II
[c] Mechanism III
[d] Mechanism IV
[e] More than one of them

**Mechanism I**

2A → C + D (slower)
D + B → 2C + A (faster)

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**Mechanism II**

A + B → C + D (slower)
A + D → 2C (faster)

**Mechanism III**
2A → C + D (slower)
D + B → 2C (faster)

**Mechanism IV**

2A + B → C + D (slower)
D → 2C (faster)

14. *Yang manakah antara mekanisma di bawah yang mungkin bagi tindakbalas,* ***2A +B → 3C****, mengikut hukum kadar,* $\boldsymbol{kadar = k(A)^2}$ *?*

*[a] Mekanisma I*
*[b] Mekanisma II*
*[c] Mekanisma III*
*[d] Mekanisma IV*
*[e] Lebih dari satu daripada yang atas*

***Mekanisma I***

*2A → C + D (perlahan)*
*D + B → 2C + A (cepat)*

***Mekanisma II***

*A + B → C + D (perlahan)*
*A + D → 2C (cepat)*

***Mekanisma III***
*2A → C + D (perlahan)*
*D + B → 2C (cepat)*

***Mekanisma IV***

*2A + B → C + D (perlahan)*
*D → 2C (cepat)*

15. Suppose that the reaction **A + 2B → D + E** has the mechanism that appears below.

**Mechanism:** A + B → C + D (slower)
C + B → E (faster)

What is the function of substance C in the reaction mechanism?

[a] reactant
[b] product
[c] catalyst
[d] intermediate
[e] transition state (activated complex)

15. *Andaikan tindakbalas* $A + 2B \rightarrow D + E$ *mempunyai mekanisma yang menyerupai di bawah.*

***Mekanisma:*** $A + B \rightarrow C + D$ *(perlahan)*
$C + B \rightarrow E$ *(cepat)*

*Apakah fungsi bahan C di dalam mekanisma tindakbalas?*

*[a]* *bahan tindakbalas*
*[b]* *produk*
*[c]* *mangkin*
*[d]* *perantaraan*
*[e]* *keadaan peralihan (kompleks teraktif)*

16. What is E° for the process $\mathbf{Cu_{(s)} \rightarrow Cu^{+}_{(aq)} + e}$ ?

[a] -0.02 V
[b] -0.19 V
[c] -0.53 V
[d] +0.19 V
[e] it is impossible to determine

16. *Apakah E° bagi proses* $\boldsymbol{Cu_{(p)} \rightarrow Cu^{+}_{(ak)} + e}$ *?*

*[a]* *-0.02 V*
*[b]* *-0.19 V*
*[c]* *-0.53 V*
*[d]* *+0.19 V*
*[e]* *mustahil untuk ditentukan*

17. Consider the electrochemical cell that is designated by the following shorthand notation: $\mathbf{Ni(s)|Ni^{2+}(aq)||Br_2(l)|Br^{-}(aq)|Pt(s)}$ where the conventions regarding relative placement of the cathode and the anode have been followed. What is the standard potential of this cell, E°cell ?

[a] -0.86 V
[b] +0.86 V
[c] +1.32 V
[d] +0.61 V
[e] none of the above

17. *Pertimbangkan sel elektrokimia yang diwakili dengan kaedah catatan ringkas:* $\boldsymbol{Ni(p)|Ni^{2+}(ak)||Br_2(c)|Br^{-}(ak)|Pt(p)}$ *di mana secara konvensyen kedudukan relatif katod dan anod diikuti. Apakah keupayaan piawai sel ini, E°sel ?*

*[a]* *-0.86 V*
*[b]* *+0.86 V*
*[c]* *+1.32 V*
*[d]* *+0.61 V*
*[e]* *Tiada satu pun yang di atas*

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18. Which of the following is the strongest reducing agent in the group?

[a] $Cl_2(g)$
[b] $Cl^-(aq)$
[c] $Zn(s)$
[d] $Zn^{2+}(aq)$
[e] $NO^{3-}(aq)$

*18. Yang manakah antara berikut adalah agen penurunan terkuat di dalam kumpulan?*

*[a]* $Cl_2(g)$
*[b]* $Cl^-(ak)$
*[c]* $Zn(p)$
*[d]* $Zn^{2+}(ak)$
*[e]* $NO^{3-}(ak)$

19. Suppose that a voltaic cell is constructed from the following half-cells that are linked by a salt bridge and a conducting (but chemically inert) wire: a manganese electrode in 1.0 M $MnCl_2(aq)$ and an iron electrode in 1.0 M $FeCl_2(aq)$. Which of the following statement is true?

[a] The manganese electrode will increase in mass as the reaction proceeds.
[b] Electrons will flow from the iron electrode to the manganese electrode.
[c] Anions will flow from the salt bridge into the manganese half-cell.
[d] [a] and [c]
[e] none of them

*19. Andaikan sel volta dibina dari sel-separuh yang dihubungkan dengan titian garam dan wayar pengaliran (tetapi lengai secara kimia): elektrod mangan di dalam 1.0 M* $MnCl_2(ak)$ *dan elektrod besi di dalam 1.0 M* $FeCl_2(ak)$. *Yang manakah penyataan berikut adalah benar?*

*[a] Jisim elektrod mangan akan meningkat apabila tindakbalas berterusan.*
*[b] Elektron akan mengalir dari elektrod besi ke elektrod mangan.*
*[c] Anion akan mengalir dari titian garam ke sel separuh mangan.*
*[d] [a] dan [c]*
*[e] Tiada satu pun yang di atas*

20. A certain transition metal, M, has the following standard reduction potentials associated with it and its ions. Use this information to calculate E° for the process $\mathbf{M^{3+} + 3e \rightarrow M}$.

$M^{3+} + e \rightarrow M^{2+}$ E° red = 0.60 V

$M^{2+} + 2e \rightarrow M$ E° red = 0.22 V

[a] E° = 0.27 V
[b] E° = 0.16 V
[c] E° = 0.35 V
[d] E° = –0.38 V
[e] It is impossible to tell

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20. *Suatu Logam peralihan, M, mempunyai keupayaan piawai penurunan berkait yang dengannya dan ionnya seperti berikut. Gunakan maklumat ini untuk mengira E° bagi proses* $M^{3+} + 3e \rightarrow M$.

$M^{3+} + e \rightarrow M^{2+}$ $\quad E°$ *penurunan* $= 0.60\ V$

$M^{2+} + 2e \rightarrow M$ $\quad E°$ *penurunan* $= 0.22\ V$

*[a]* $E° = 0.27\ V$
*[b]* $E° = 0.16\ V$
*[c]* $E° = 0.35\ V$
*[d]* $E° = -0.38\ V$
*[e] mustahil untuk ditentukan*

21. Consider two aqueous solutions of sucrose, $C_{12}H_{22}O_{11}$, at 25°C, one saturated and the other unsaturated. The vapor pressure of both solutions is measured. Then, the lids are removed and some water is allowed to evaporate from both solutions. The lids are then replaced and the vapor pressures are again measured. Which solution has a different vapor pressure now than it did before?

[a] the saturated one
[b] the unsaturated one
[c] both solutions
[d] neither solution
[e] it is impossible to tell

21. *Pertimbangkan dua larutan akues sukrosa,* $C_{12}H_{22}O_{11}$, *pada suhu 25°C, satu tepu dan satu tak-tepu. Tekanan wap kedua-dua larutan diukur. Kemudian penutup dialihkan dan jumlah air dibiarkan untuk tersejat daripada kedua-dua larutan. Penutup diletakkan kembali dan tekanan wap sekali lagi diukur. Larutan yang manakah mempunyai tekanan wap yang berbeza berbanding sebelumnya?*

*[a] larutan tepu*
*[b] larutan tak-tepu*
*[c] kedua-dua larutan*
*[d] bukan mana-mana larutan*
*[e] mustahil untuk ditentukan*

22. A solution consisting of a nonvolatile, covalent (non-electrolyte) compound dissolved in water is placed in a tube with a semipermeable membrane on one end. This tube is placed in a beaker of pure water. What would happens?

[a] The compound will flow from the tube to the beaker.
[b] Water will flow from the tube to the beaker.
[c] Water will flow from the beaker to the tube.
[d] Nothing will move either way.
[e] It is impossible to tell

22. *Larutan mempunyai sebatian tak-meruwap, kovalen (tak-elektrolit) dilarutkan di dalam air yang ditempatkan di dalam tiub dengan membran separa resap di satu hujungnya. Tiub ini telah diletakkan di dalam bikar yang mempunyai air tulen. Apakah yang akan terjadi?*

*[a] Sebatian akan mengalir dari tiub ke bikar.*
*[b] Air akan mengalir dari tiub ke bikar.*
*[c] Air akan mengalir dari bikar ke tiub.*
*[d] Tiada pergerakan dari kedua-dua arah.*
*[e] Mustahil untuk ditentukan.*

23. Which of the following 0.10 M aqueous solutions has the lowest melting point? Assume theoretical van't Hoff values "*i*".

[a] $K_2[CuCl_4]$
[b] $K_4[Mn(CN)_6]$
[c] $[Co(NH_3)_4(NO_2)_2]Cl$
[d] $[Cr(NH_3)_6](ClO_4)_3$
[e] it is impossible to tell

23. *Manakah antara berikut larutan 0.10 M akues yang mempunyai titik lebur terendah? Anggapkan nilai-nilai teori van't Hoff "i"*

*[a]* $K_2[CuCl_4]$
*[b]* $K_4[Mn(CN)_6]$
*[c]* $[Co(NH_3)_4(NO_2)_2]Cl$
*[d]* $[Cr(NH_3)_6](ClO_4)_3$
*[e] mustahil untuk ditentukan*

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Lampiran

## Standard Reduction Potentials at 25°C

| *Half Reaction* | *E°, volts* |
|---|---|
| $F_2(g) + 2e \rightarrow 2F^-(aq)$ | +2.87 |
| $Au^{3+}(aq) + 3e \rightarrow Au(s)$ | +1.50 |
| $Cl_2(g) + 2e \rightarrow 2Cl^-(aq)$ | +1.36 |
| $Br_2(l) + 2e \rightarrow 2Br^-(aq)$ | +1.07 |
| $NO_3^-(aq) + 4H^+(aq) + 3e \rightarrow NO(g) + 2H_2O(l)$ | +0.96 |
| $Ag^+(aq) + e \rightarrow Ag(s)$ | +0.80 |
| $Cu^{2+}(aq) + 2e \rightarrow Cu(s)$ | +0.34 |
| $Cu^{2+}(aq) + e \rightarrow Cu^+(aq$ | +0.15 |
| $2H^+(aq) + 2e \rightarrow H_2(g)$ | +0.00 |
| $Sn^{2+}(aq) + 2e \rightarrow Sn(s)$ | −0.14 |
| $Ni^{2+}(aq) + 2e \rightarrow Ni(s)$ | −0.25 |
| $Fe^{2+}(aq) + 2e \rightarrow Fe(s)$ | -0.44 |
| $Zn^{2+}(aq) + 2e \rightarrow Zn(s)$ | −0.76 |
| $Mn^{2+}(aq) + 2e \rightarrow Mn(s)$ | −1.18 |
| $Na^+(aq) + e \rightarrow Na(s)$ | -2.71 |
| $K^+(aq) + e \rightarrow K(s)$ | -2.93 |

## PERIODIC CHART OF THE ELEMENTS

| IA | IIA | IIIB | IVB | VB | VIB | VIIB | VIII | VIII | VIII | IB | IIB | IIIA | IVA | VA | VIA | VIIA | INERT GASES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 H 1.00797 | | | | | | | | | | | | | | | | | 2 He 4.0026 |
| 3 Li 6.939 | 4 Be 9.0122 | | | | | | | | | | | 5 B 10.811 | 6 C 12.0112 | 7 N 14.0067 | 8 O 15.9994 | 9 F 18.9984 | 10 Ne 20.183 |
| 11 Na 22.9898 | 12 Mg 24.312 | | | | | | | | | | | 13 Al 26.9815 | 14 Si 28.086 | 15 P 30.9738 | 16 S 32.064 | 17 Cl 35.453 | 18 Ar 39.948 |
| 19 K 39.102 | 20 Ca 40.08 | 21 Sc 44.956 | 22 Ti 47.90 | 23 V 50.942 | 24 Cr 51.996 | 25 Mn 54.9380 | 26 Fe 55.847 | 27 Co 58.9332 | 28 Ni 58.71 | 29 Cu 63.54 | 30 Zn 65.37 | 31 Ga 69.72 | 32 Ge 72.59 | 33 As 74.9216 | 34 Se 78.96 | 35 Br 79.909 | 36 Kr 83.80 |
| 37 Rb 85.47 | 38 Sr 87.62 | 39 Y 88.905 | 40 Zr 91.22 | 41 Nb 92.906 | 42 Mo 95.94 | 43 Tc (99) | 44 Ru 101.07 | 45 Rh 102.905 | 46 Pd 106.4 | 47 Ag 107.870 | 48 Cd 112.40 | 49 In 114.82 | 50 Sn 118.69 | 51 Sb 121.75 | 52 Te 127.60 | 53 I 126.904 | 54 Xe 131.30 |
| 55 Cs 132.905 | 56 Ba 137.34 | *57 La 138.91 | 72 Hf 178.49 | 73 Ta 180.948 | 74 W 183.85 | 75 Re 186.2 | 76 Os 190.2 | 77 Ir 192.2 | 78 Pt 195.09 | 79 Au 196.967 | 80 Hg 200.59 | 81 Tl 204.37 | 82 Pb 207.19 | 83 Bi 208.980 | 84 Po (210) | 85 At (210) | 86 Rn (222) |
| 87 Fr (223) | 88 Ra (226) | †89 Ac (227) | 104 Rf (261) | 105 Db (262) | 106 Sg (266) | 107 Bh (262) | 108 Hs (265) | 109 Mt (266) | 110 ? (271) | 111 ? (272) | 112 ? (277) | | | | | | |

Numbers in parenthesis are mass numbers of most stable or most common isotope.

Atomic weights corrected to conform to the 1963 values of the Commission on Atomic Weights.

The group designations used here are the former Chemical Abstract Service numbers.

*Lanthanide Series

| 58 Ce 140.12 | 59 Pr 140.907 | 60 Nd 144.24 | 61 Pm (147) | 62 Sm 150.35 | 63 Eu 151.96 | 64 Gd 157.25 | 65 Tb 158.924 | 66 Dy 162.50 | 67 Ho 164.930 | 68 Er 167.26 | 69 Tm 168.934 | 70 Yb 173.04 | 71 Lu 174.97 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

†Actinide Series

| 90 Th 232.038 | 91 Pa (231) | 92 U 238.03 | 93 Np (237) | 94 Pu (242) | 95 Am (243) | 96 Cm (247) | 97 Bk (247) | 98 Cf (249) | 99 Es (254) | 100 Fm (253) | 101 Md (256) | 102 No (256) | 103 Lr (257) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

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Ciri-ciri termodinamik dalam keadaan piawai (25°C dan 1 bar)

| Bahan | $\Delta_f H°_{298}$ (kJmol$^{-1}$) | $\Delta_f G°_{298}$ (kJmol$^{-1}$) | $S°_{m,298}$ (Jmol$^{-1}$K$^{-1}$) | $C_P°_{m,298}$ (kJmol$^{-1}$ K$^{-1}$) |
|---|---|---|---|---|
| $Ag^+$ (ak) | 105.56 | 77.09 | 72.8 | - |
| Br (g) | 111.884 | 82.396 | 175.022 | 20.786 |
| $Br^+$ (aq) | -121.55 | -103.97 | 82.4 | -141.8 |
| $Br_2$ (l) | 0 | 0 | 152.231 | 75.689 |
| $Br_2$ (g) | 30.907 | 3.110 | 245.463 | 36.02 |
| C (grafit) | 0 | 0 | 5.740 | 8.527 |
| C (berlian) | 1.897 | 2.900 | 2.377 | 6.115 |
| C (g) | 716.682 | 671.257 | 158.096 | 20.838 |
| $CF_4$ (g) | -925 | -879 | 261.61 | 61.09 |
| $CH_4$ (g) | -74.81 | -50.72 | 186.264 | 35.309 |
| CO (g) | -110.525 | -137.168 | 197.674 | 29.116 |
| $CO_2$ (g) | -393.509 | -394.359 | 213.74 | 37.11 |
| $CO_3^{2-}$ (aq) | -677.14 | -527.81 | -56.9 | - |
| $COF_2$ (g) | -634.7 | -619.2 | 258.60 | 46.82 |
| $C_2H_2$ (g) | 226.73 | 209.20 | 200.94 | 43.93 |
| $C_2H_4$ (g) | 52.26 | 68.15 | 219.56 | 43.56 |
| $C_2H_6$ (g) | -84.68 | -32.82 | 229.60 | 52.63 |
| $C_2H_5OH$ (l) | -277.69 | -174.78 | 160.7 | 111.46 |
| $(CH_3)_2O$ (g) | -184.05 | -112.59 | 266.38 | 64.39 |
| $C_3H_8$ (g) | -103.85 | -23.37 | 270.02 | 73.51 |
| $C_6H_6$ (g) | 82.93 | 129.7 | 269.31 | 81.67 |
| $C_6H_{10}$ (g) | -5.36 | 107.0 | 310.86 | 105.02 |
| $C_6H_{12}O_6$ (c) | -1274.4 | -910.1 | 212.1 | 218.8 |
| $C_{12}H_{22}O_{11}$ (c) | -2221.7 | -1543.8 | 360.2 | 425.5 |
| $CH_3(CH_2)_{14}COOH$ (c) | -890.8 | -314.5 | 455.2 | 460.7 |
| $CaCO_3$ (kalsit) | -1206.92 | -1128.79 | 92.9 | 81.88 |
| $CaCO_3$ (arigonit) | -1207.13 | -1127.75 | 88.7 | 81.25 |
| CaO (c) | -635.09 | -604.03 | 39.75 | 42.80 |
| Cl (g) | 121.679 | 105.680 | 165.198 | 21.840 |
| $Cl^-$ (aq) | -167.159 | -131.228 | 56.5 | -136.4 |
| $Cl_2$ (g) | 0 | 0 | 223.066 | 33.907 |
| Cu (c) | 0 | 0 | 33.150 | 24.435 |
| $Cu^{2+}$ (aq) | 64.77 | 65.49 | -99.6 | - |
| $F_2$ (g) | 0 | 0 | 202.78 | 31.30 |
| Fe (c) | 0 | 0 | 27.28 | 25.10 |
| $Fe^{3+}$ (aq) | -48.5 | -4.7 | -315.9 | - |
| H (g) | 217.965 | 203.247 | 114.713 | 20.784 |
| $H^+$ (aq) | 0 | 0 | 0 | 0 |
| $H_2$ (G) | 0 | 0 | 130.684 | 28.824 |
| HD (g) | 0.318 | -1.464 | 143.801 | 29.196 |

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| | | | | |
|---|---|---|---|---|
| $D_2$ (g) | 0 | 0 | 144.960 | 29.196 |
| HBr (g) | -36.40 | -53.45 | 198.695 | 29.142 |
| HCl (g) | -92.307 | -95.299 | 186.908 | 29.12 |
| HF (g) | -271.1 | -273.2 | 173.779 | 29.133 |
| $HN_3$ (g) | 294.1 | 328.1 | 238.97 | 43.68 |
| $H_2O$ (l) | -285.830 | -237.129 | 69.91 | 75.291 |
| $H_2O$ (g) | -241.818 | -228.572 | 188.825 | 33.577 |
| $H_2O_2$ (l) | -187.78 | -120.35 | 109.6 | 89.1 |
| $H_2S$ (g) | -20.63 | -33.56 | 205.79 | 34.23 |
| $K^+$ (aq) | -252.38 | -283.27 | 102.5 | 21.8 |
| KCl (c) | -436.747 | -409.14 | 82.59 | 51.30 |
| Mg (c) | 0 | 0 | 32.68 | 24.89 |
| Mg (g) | 147.70 | 113.10 | 148.650 | 20.786 |
| MgO (c) | -601.70 | -569.44 | 26.94 | 37.15 |
| N (g) | 472.704 | 455.563 | 153.298 | 20.786 |
| $N_2$ (g) | 0 | 0 | 191.61 | 29.125 |
| $NH_3$ (g) | -46.11 | -16.45 | 192.45 | 35.06 |
| $NH_2CH_2COOH$ (c) | -528.10 | -368.44 | 103.51 | 99.20 |
| NO (g) | 90.25 | 86.55 | 210.761 | 29.844 |
| $NO_2$ (g) | 33.18 | 51.31 | 240.06 | 37.20 |
| $NO_3^-$ (aq) | -207.36 | -111.25 | 146.4 | -86.6 |
| $N_2O_4$ (g) | 9.16 | 97.89 | 304.29 | 77.28 |
| Na (g) | 107.32 | 76.761 | 153.712 | 20.786 |
| $Na^+$ (aq) | -240.12 | -261.905 | 59.0 | 46.4 |
| NaCl (c) | -411.153 | -384.138 | 72.13 | 50.50 |
| O (g) | 249.170 | 231.731 | 161.055 | 21.912 |
| $O_2$ (g) | 0 | 0 | 205.138 | 29.355 |
| $OH^-$ (aq) | -229.994 | -157.244 | -10.75 | -148.5 |
| $PCl_3$ (g) | -287.0 | -267.8 | 311.78 | 71.84 |
| $PCl_5$ (g) | -374.9 | -305.0 | 364.58 | 112.80 |
| $SO_2$ (g) | -296.830 | -300.194 | 248.22 | 39.87 |
| Si (g) | 455.6 | 411.3 | 167.97 | 22.251 |
| SiC (β, kiub) | -65.3 | -62.8 | 16.61 | 26.86 |
| $SiO_2$ (kuartz) | -910.94 | -856.64 | 41.84 | 44.43 |
| Sn (kelabu) | -2.09 | 0.13 | 44.14 | 25.77 |
| Sn (putih) | 0 | 0 | 51.55 | 26.99 |
| $SO_4^{2-}$ (aq) | -909.27 | -744.53 | 20.1 | -293 |

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Sistem unit penukaran

| Kuantiti | Nilai kesamaan |
|---|---|
| Jisim | 1 kg = 1000 g = 0.001 tan metrik = 2.20462 $lb_m$ = 35.27392 aun<br>1 $lb_m$ = 16 aun = $5\times10^{-4}$ tan = 453.593 g = 0.453593 kg |
| Panjang | 1 m = 100 sm = 1000 mm = $10^6$ μm = $10^{10}$ angstrom = 39.37 in<br>= 3.2808 ka = 1.0936 ela = 0.0006214 batu. |
| Isipadu | 1 $m^3$ = 1000 L = $10^6$ $sm^3$ = $10^6$ml<br>= 35.3145 $ka^3$ = 264.17 gal<br>1 $ka^3$ = 1728 $in^3$ = 7.4805 gal = 0.028317 $m^3$ = 28.317 L = 28317 $sm^3$ |
| Daya | 1 N = 1 kg.m.$s^{-2}$ = $10^5$ dyne = $10^5$ g.sm.$s^{-2}$ = 0.22481 $lb_f$<br>1 $lb_f$ = 32.174 $lb_m$ ft.$s^{-2}$ = 4.4482 N |
| Tekanan | 1 atm = $1.01325\times10^5$ $N/m^2$ (Pa) = $1.01325\times10^5$ kg/(m.$s^2$) = 760 torr<br>= 760 mmHg = 14.696 psi |
| Tenaga | 1 J = 1 N.m = $10^7$ dyne.sm = $2.778\times10^{-7}$ kW.h = 0.23901 kal<br>= 0.7376 ka-$lb_f$ = $9.486\times10^{-4}$ Btu |
| Kuasa | 1 W = 1 J/s = 0.23901 kal/s = 0.7376 ka-$lb_f$/s = $9.486\times10^{-4}$ Btu/s<br>= $1.341\times10^{-3}$ hp |

| Pemalar Gas | Pemalar Faraday | Persamaan-persamaan |
|---|---|---|
| 8.314 $m^3$.Pa/mol.K<br>0.08314 liter. bar/mol.K<br>0.08206 liter.atm/mol.K<br>62.36 liter.mmHg/mol.K<br>0.7302 $ft^3$.atm/lb-mole.°R<br>10.73 $ft^3$.psia/lb-mole.°R<br>8.314 J/mol.K<br>1.987 kal/mol.K<br>1.987 Btu/lb-mole.°R | 96485 C/mol | $\zeta = \zeta^\circ - \frac{RT}{nF}\ln\left[\prod_i (a_i)^{\nu_i}\right]$<br>$= \zeta^\circ - \frac{RT}{nF}\ln Q$<br><br>Tindakbalas tertib ke-n<br>$\left(\frac{[A]}{[A]_o}\right)^{1-n} = 1 + [A]_o^{n-1}(n-1)k_a t$<br>untuk $n \neq 1$. |